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AUTHOR McShannon, Judy; Derlin, Roberta
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ABSTRACT

In the context of studies of retaining minority and women students in engineering, this study explored how students perceived that they learned best, how they interacted with other students and faculty, and how students interacted differently during class and between classes in pursuing their engineering studies. The sample was 515 undergraduate engineering students in 3 colleges in New Mexico. Exploratory factor analyses and confirmatory factor analyses were performed in responses to a paper and pencil student survey. Analysis of this data suggested that interactive learning styles differed among respondent subgroups, including male and female, white and minority, and freshmen and seniors. The interactive learning style of students learning by themselves contributed most to the success of four of the six respondent groups. Learning with other students contributed most highly to minority student success, while learning with faculty in an informal environment outside of class contributed most to freshman success. Traditional instructional strategies appeared to support the students who are most commonly successful in engineering programs, but these strategies may not provide the support more diverse students need to achieve positive student outcomes. (Contains 1 table and 10 references.) (SLD)

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How Faculty Development and Research Can Foster Student Success

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Abstract

The problem of low graduation rates for diverse students in engineering has many causes. Faculty and administrators agree, not all students can, or should, become engineers. But, are the students who leave really those who are unable to handle to course work? While many factors influence a university student's decision to remain or leave a particular field of study or the pursuit of higher education entirely, many of the known factors are beyond the control of university faculty or administrators. However, the presentation of instruction in ways that support how students learn best to acquire new information in an unfamiliar academic environment (their interactive learning style) is a factor that is subject to the influence of faculty and the administrators who are responsible for academic program design. This study explored how students perceive that they learned best, how students interacted with other students and faculty, and how students interact differently during class and between classes in pursuing their engineering studies.

The study sample was 515 undergraduate engineering students enrolled in the three accredited engineering colleges in New Mexico. Exploratory factor and confirmatory factor analyses were performed on responses to a paper and pencil student survey. The analysis of the data suggested that interactive learning styles are different among various respondent subgroups including, male and female, white and minority, and freshmen and seniors. The interactive learning style of students learning by themselves contributed most to the success of four of the six respondent groups. However, the two groups which have the lowest retention rate nationwide, minorities and freshmen, stated that they interacted differently from other students when they learned best. Learning with other students contributed most highly to minority student success, while learning with faculty in an informal environment, outside of class, contributed most to freshmen student success. While traditional instructional strategies appear to support the students who are most commonly successful in engineering programs, these same strategies may fail to provide the support more diverse students need to achieve positive student outcomes. By providing the information learned about interactive learning styles, academic program administrators and faculty can become aware of alternative instructional strategies that can encourage the same level of participation and inclusion by both diverse and traditional students.

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Methods and Sampling

The study examined if there are differences by gender (male/female), ethnicity (white/minority), and college class (freshmen/senior) in how students perceive they learn best. For the purpose of this study, interactive learning style was defined as the person or persons whom the student interacts with when learning, such as the faculty, other students, or no one. The Interactive Learning Styles Inventory (McShannon, 1998) was administered in the spring semester of 1998 to students enrolled in selected classes at the University of New Mexico (N=172) , New Mexico State University (N=247), and New Mexico Institute of Mining and Technology (N=96). Students completed the survey during a engineering class they were taking at the various sites. There were a total of 596 questionnaires collected, 515 questionnaires were used for the analysis due to missing data or permission forms. Respondent information is shown in Table 1.

Table 1
Respondent Information

	Male	Female	White	Minority	Freshman	Senior
Sample Number	386	127	246	257	183	166
Sample Percentage	75%	25%	49%	51%	52%	48%
Population Percentage	76%	24%	59%	41%	43%	57%

Analysis & Findings

Exploratory factor and LISREL confirmatory factor analyses were used to examine whether the interactive learning styles for diverse students; men and women, whites and minority, and freshmen and seniors are the same. Seven measures were considered to determine if the LISREL comparisons suggested that the interactive learning styles of the groups were similar or different; chi square, adjusted chi square, goodness of fit, adjusted goodness of fit, residuals, root mean square residuals, and modification indices. The seven measures relevant to the overall goodness of fit indicated the interactive learning styles were different. For all subgroups, the adjusted χ^2 is greater than desired value of 2.0, the adjusted goodness-of-fit is less than 0.89 desired, and the root mean residual is greater than the desired value of .05. Analysis of the standardized residuals show many are greater than the desired 2.0 and the Q-Plots of the residuals do not follow the required 45-degree angle. Modification indices for the data indicate several fell above the desired 5.0, with ranges from 5.09 to 68.65. In some comparisons, the group differences in interactive learning styles were so substantial that several measures were unable to be examined. Examination of these seven measures confirms that the interactive learning styles of men and women, white and minority, and freshmen and seniors, are different.

Discussion of the Findings

This study supports prior research (Adams, 1992; Aluko, 1994; Endo & Harpel, 1982; Fassinger, 1995; Grayson & Martin, 1984; Guthman, 1992; McShannon, 1998; McShannon & Derlin, 1999; Powell, 1994) in suggesting that, while interacting with faculty is important for student development, not all students interact with faculty in the same manner. Like learning styles, students have a dominant interaction style. Interaction styles are the way, and with whom, students interact when they learn. This research revealed four basic interaction styles:

- Student-faculty-formal (during class): students who learn best by interacting with faculty during class
- Student-faculty-informal (outside of class): students who learn best by interacting with faculty outside of class (after class, during office hours, through email or phone)
- Student-Student: students who learn best by interacting with other students (both during class and outside of class)
- Student-Self: students who learn best by themselves

The Student-Self learning style (students who learn best by themselves) was the particular interactive learning style that contributed most to how students perceived they learned best in four of the six comparison groups. However, the two groups which have the lowest retention rate nationwide, minorities and freshmen, did find that the Student-Self learning style contributed the most to their success. The Student-Student learning style (students who learn best by learning with other students) contributed most for the minority group. The Student-Faculty-Informal learning style (students who learn best by interacting with their faculty outside of class) contributed most for the freshmen group. This suggests that faculty could include or increase the use of instructional methods that would foster students working together to study content material, specifically encouraging the participation of minority students. Similarly, freshmen students might benefit from the inclusion of opportunities to work with faculty outside of the classroom setting, in more informal atmospheres.

The Student-Faculty-Formal (students who learn best by interacting with their faculty during class), and the Student-Faculty-Informal (students who learn best by interacting with their faculty outside of class); also contributed to varying degrees among the comparison groups. This finding suggests that, when interacting with the faculty, students perceive that the setting or learning environment is important. While all students value formal interaction with faculty similarly and all students find informal interaction with faculty useful in pursuing their studies, freshmen and female students find informal interactions with faculty particularly pertinent to their acquiring new information.

Freshmen and female students are also similar to each other in their perceptions about learning with other students but quite different from the other student groups. Freshmen and female students do not emphasize the Student-Student learning style while the other student groups consider interacting with other students to be the most, or at least a very important, contributing factor to their learning best. These differences observed among the groups suggest that faculty could increase opportunities for interaction with freshmen and female students in an effort to support their learning style.

Student-Self, Student-Student, and Student-Faculty-Informal learning styles were ranked among the first three most important learning styles by all comparison groups and faculty could increase these learning opportunities for all students by implementing more varied instructional approaches. The differences in interactive learning style among the students in this study also suggest that providing supportive instructional practice in varied ways to different groups of students may help them to achieve positive student outcomes in their engineering studies. The differences between comparison groups that are important, include:

- While white students and seniors learn best by themselves, minority students and freshmen find self study strategies less useful in acquiring new engineering information;
- Male students, minority students, and seniors find interaction with other students both during class and outside of class more useful in acquiring new engineering information than female, white or freshman students. Providing cooperative learning exercises during or between classes are supportive instructional strategies that can positively influence student outcomes for men, minority, and senior students.
- Freshman and female students find informal interaction with faculty more important to their learning than either senior or male students. Offering students opportunities to interact with faculty in an informal environment (outside of class), in an academically meaningful way, can contribute positively to freshman and female student outcomes.
- All students value opportunities to interact with faculty during class sessions. Faculty can frequently engage their students during class in supportive ways and assure that all students are included in these interaction opportunities to positively influence outcomes for all students.

The students who are traditionally most successful in undergraduate engineering programs, the seniors and whites, have the interactive learning style which is used most often in these programs, students learning by themselves. While this traditional instructional strategy supports some students, it fails to provide the same opportunities to more diverse students. The students who are less likely to be retained in the engineering courses, the freshmen, minority and female students, learn new engineering information most successfully when other instructional strategies are applied. Academic program administrators can support positive student outcomes and student retention in engineering programs by communicating with faculty about how varying instructional practice can support the varied ways in which students learn new information. Faculty awareness of alternative instructional strategies can encourage participation and inclusion by diverse students.

Many engineering programs are including team work and group work as part of their curriculum, while only a few incorporate informal faculty interaction. These factors may be contributing to the retention problem in engineering schools. Providing more opportunities for diverse students to learn in ways that they perceive supports their learning will foster positive student outcomes and their retention in engineering programs.

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